

Having thus described the invention, what is claimed as new and secured by Letters Patent is:

1. An apparatus for performing electromagnetic treatment on processed metallurgical materials and products, said apparatus comprising:
  - a holder for a work piece;
  - a power supply for providing voltage and current to at least one electromagnetic coil;
  - a thermal source for varying temperature of said work piece and each electromagnetic coil;
  - at least one sensor;
  - a data acquisition means for recording data measured by at least one sensor; and
  - a processor for controlling, monitoring, and analyzing at least one operating parameter of said electromagnetic treatment;wherein said power supply is coupled to each electromagnetic coil, said holder is located proximate to said electromagnetic coil, said thermal source is coupled to said holder and said electromagnetic coil, and said processor is coupled to said power supply, said data acquisition means, and said thermal source.
2. The apparatus as claimed in Claim 1 wherein said power supply includes
  - a means for generating an alternating current component having harmonic shapes with controlled characteristics,
  - a means for imposing a direct current with a constant bias on said alternating current component, and
  - a means for varying frequency of said alternating current component.
3. An apparatus for performing electromagnetic treatment and thermal-chemical treatments simultaneously on processed engineering materials and products, said apparatus comprising:
  - a holder for a work piece;

a power supply for providing voltage and current to at least one electromagnetic coil;

a heating/cooling source for varying the temperature of said work piece and each electromagnetic coil;

a thermo-chemical treatment system;

at least one sensor;

a data acquisition means for recording data measured by at least one sensor; and

a processor for controlling, monitoring, and analyzing at least one operating parameter of said electromagnetic treatment;

wherein said power supply is coupled to each electromagnetic coil, said holder is located proximate to said electromagnetic coil, said heating/cooling source is coupled to said holder and said electromagnetic coil, said thermo-chemical treatment system is connected to said work piece, and said processor is coupled to said power supply, said data acquisition means, and said thermal source.

4. The apparatus as claimed in Claim 3 wherein said power supply includes a means for generating an alternating current component having harmonic shapes with controlled characteristics,

a means for imposing a direct current with a constant bias on said alternating current component, and

a means for varying frequency of said alternating current component.

5. An apparatus for optimizing electromagnetic treatment processes for processed engineering materials and products, said apparatus comprising:

a holder for a work piece;

a power supply for providing voltage and current to at least one electromagnetic coil;

a thermal source for varying the temperature of said work piece and each electromagnetic coil;

at least one sensor;

a data acquisition means for recording data measured by at least one sensor; and

a computer for controlling, monitoring, and analyzing at least one operating parameter of said electromagnetic treatment and for adjusting at least one operating parameter based on said data acquired by said data acquisition means;

wherein said power supply is coupled to each electromagnetic coil, said holder is located proximate to said electromagnetic coil, said thermal source is coupled to said holder and said electromagnetic coil, said computer is coupled to said power supply, said data acquisition means, and said thermal source, said computer uses an Advanced Thermal Analysis (ATA) technique to analyze the thermal signature of said work piece during said electromagnetic treatment.

6. The apparatus as claimed in Claim 5 wherein said power supply includes a means for generating an alternating current component having harmonic shapes with controlled characteristics,

a means for imposing a direct current with a constant bias on said alternating current component, and

a means for varying frequency of said alternating current component.

7. A method for optimizing electromagnetic treatment processes for processed metallurgical materials and products, said method comprising the steps of:

applying, at a given temperature, an Electromagnetic (EM) Field to a work piece;

measuring operating parameters of said electromagnetic treatment process;

recording and storing said measured operating parameters in a database;

and

applying heating, cooling, or isothermal holding cycles to said work piece;

adding chemical additives to improve certain metallurgical characteristics of said work piece;

analyzing physical characteristics of said work piece during and after the completion of said electromagnetic treatment process;

wherein said method is repeated until said physical characteristics of said work piece are optimized.

8. A method for optimizing electromagnetic treatment processes for processed metallurgical materials and products, said method comprising the steps of:

- applying, through a temperature range, an Electromagnetic (EM) Field to a work piece;
- measuring operating parameters of said electromagnetic treatment process;
- recording and storing said measured operating parameters in a database;
- and
- applying heating, cooling, isothermal holding cycles to said work piece;
- adding chemical additives to improve certain metallurgical characteristics of said work piece;
- analyzing physical characteristics of said work piece during and after the completion of said electromagnetic treatment process;
- wherein said method is repeated until said physical characteristics of said work piece are optimized.

9. A method for optimizing electromagnetic treatment processes for processed metallurgical materials and products, said method comprising the steps of:

- applying, for a given time period, an Electromagnetic (EM) Field to a work piece;
- measuring operating parameters of said electromagnetic treatment process;
- recording and storing said measured operating parameters in a database;
- and
- applying heating, cooling, isothermal holding cycles to said work piece;
- adding chemical additives to improve certain metallurgical characteristics of said work piece;
- analyzing physical characteristics of said work piece during and after the completion of said electromagnetic treatment process;
- wherein said method is repeated until said physical characteristics of said work piece are optimized.